DETAILED ACTION

1. Claims 1, 6, 9, 12, 16-18, 20, 25, 27-28 are pending in the application.

2. Claims 2-5, 7-8, 10-11, 13-15, 19, 21-24, 26 & 29 have been canceled.

EXAMINER'S AMENDMENT

3. An examiner's amendment to the record appears below. Should the changes
   and/or additions be unacceptable to applicant, an amendment may be filed as
   provided by 37 CFR 1.312. To ensure consideration of such an amendment, it
   MUST be submitted no later than the payment of the issue fee.

   Authorization for this examiner's amendment was given in a telephone interview
   with Dan McClure on 11/18/2009.

   The Claims have been amended as follows:

   - **Replace** Claim 1 **with**:

   An apparatus for carrier frequency offset compensation at a receiver of a
   communication system, wherein a symbol signal modulated by a carrier is
   transmitted via a plurality of subchannels, wherein the symbol signal comprises a
   pilot signal and the subchannels comprise at least a pilot subchannel for transmitting
   the pilot signal, the apparatus comprising:

   a pilot subchannel estimator for generating an estimated frequency response of
   the pilot signal;

   a frequency offset estimator, coupled to the pilot subchannel estimator, for
   generating an estimated carrier frequency offset according to a phase error between
   the estimated frequency response of the symbol signal in a frequency domain and

an estimated frequency response of a following symbol signal in the frequency
domain;

a phase accumulator, coupled to the frequency offset estimator, for calculating
an accumulated phase rotation according to the estimated carrier frequency offset;
and

a phase rotator, coupled to the phase accumulator, for carrier frequency offset
compensation according to the accumulated phase rotation, wherein based on value
of the estimated carrier frequency offset, the phase rotator performs frequency offset
compensation in either the time domain or the frequency domain;

wherein if the subchannels comprise a plurality of the pilot subchannels for
transmitting a plurality of pilot signals, then the pilot subchannel estimator is for
generating a plurality of estimated frequency responses corresponding to the pilot
signals, and the frequency offset estimator coupled to the pilot subchannel estimator
is for generating an estimated carrier frequency offset according to the estimated
frequency responses of one of the pilot signals of the symbol signal and that of a
corresponding pilot signal of a following symbol signal; and

further wherein the estimated carrier frequency offset is generated through
generating a plurality of phase errors, wherein each of the phase errors is generated
according to the estimated frequency response of one of the pilot signals of the
symbol signal and that of a corresponding pilot signal of the following symbol signal,
and then averaging the phase errors.

- **Cancel** <u>Claims 4 & 5</u>.

- **Replace** Claim 6 **with**:

An apparatus for phase compensation at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises a pilot signals and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal, the apparatus comprising:

a pilot subchannel estimator for generating an estimated frequency response corresponding to each pilot subchannel;

a frequency offset estimator coupled to the pilot subchannel estimator for generating an estimated carrier frequency offset according to the estimated frequency responses of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of a following symbol signal;

a carrier frequency offset compensator coupled to the frequency offset estimator to perform a carrier frequency offset compensation on the symbol signal;

a channel compensator to perform a channel compensation on the symbol signal;

a phase error estimator for extracting the pilot signal and generating an estimated residual phase error between the extracted pilot signal and an original pilot signal;

a buffer for storing the estimated residual phase error; and a phase rotator, coupled to the buffer, for compensating a following symbol signal according to the estimated residual phase error;

wherein the following symbol signal is compensated by the channel compensator after being compensated by the phase rotator;

wherein if the subchannels comprise a plurality of the pilot subchannels for transmitting a plurality of pilot signals, then the pilot subchannel estimator is for generating a plurality of estimated frequency responses corresponding to the pilot signals, and the frequency offset estimator coupled to the pilot subchannel estimator is for generating an estimated carrier frequency offset according to the estimated frequency responses of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of a following symbol signal; and

further wherein the estimated carrier frequency offset is generated through generating a plurality of phase errors, wherein each of the phase errors is generated according to the estimated frequency response of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of the following symbol signal, and then averaging the phase errors.

- **Cancel** Claim 8.

- **Replace** Claim 9 **with**:

An apparatus for phase compensation at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises a least a pilot

signal and at least a data signal, and the subchannels comprise at least a pilot

subchannel for transmitting the pilot signal and at least a data subchannel for

transmitting the data signal, the apparatus comprising:

a pilot subchannel estimator for generating an estimated frequency response

corresponding to each pilot subchannel;

a frequency offset estimator coupled to the pilot subchannel estimator for

generating an estimated carrier frequency offset according to the estimated

frequency responses of one of the pilot signals of the symbol signal and that of a

corresponding pilot signal of a following symbol signal;

a carrier frequency offset compensator to perform a carrier frequency offset

compensation on the symbol signal;

a buffer for storing the symbol signal after carrier frequency offset

compensation;

a pilot subchannel compensator, coupled to the buffer, for compensating the

pilot signal to generate a channel-compensated pilot signal;

a phase error estimator, coupled to the pilot subchannel compensator, for

generating an estimated residual phase error between the channel-compensated

pilot signal and an original pilot signal;

a phase rotator for compensating the data signal according to the estimated

residual phase error;

wherein the data signal is compensated by a data subchannel compensator

after being compensated by the phase rotator;

wherein if the subchannels comprise a plurality of the pilot subchannels for transmitting a plurality of pilot signals, then the pilot subchannel estimator is for generating a plurality of estimated frequency responses corresponding to the pilot signals, and the frequency offset estimator coupled to the pilot subchannel estimator is for generating an estimated carrier frequency offset according to the estimated frequency responses of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of a following symbol signal; and

further wherein the estimated carrier frequency offset is generated through generating a plurality of phase errors, wherein each of the phase errors is generated according to the estimated frequency response of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of the following symbol signal, and then averaging the phase errors.

- **Cancel** <u>Claim 11</u>.

- **Replace** <u>Claim 12</u> **with**:

A compensating module at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises at least a pilot signal and at least a data signal, and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal and at least a data subchannel for transmitting the data signal, the compensating module comprising:

a frequency offset compensator to perform a frequency offset compensation on the symbol signal according to an estimated frequency response of the pilot

subchannel transmitting the pilot signal, the frequency offset compensator comprising:

a pilot subchannel estimator for generating the estimated frequency response of the pilot signal;

a frequency offset estimator, coupled to the pilot subchannel estimator, for generating the estimated carrier frequency offset according to the phase error between the estimated frequency response of the pilot signal of the symbol signal in a frequency domain and the estimated frequency response of the pilot signal of a following symbol signal in the frequency domain;

a phase accumulator, coupled to the frequency offset estimator, for calculating an accumulated phase rotation according to the estimated carrier frequency offset;

a phase rotator, coupled to the phase accumulator, for performing frequency offset compensation according to the accumulated phase rotation, wherein based on the magnitude of the carrier frequency offset, the phase rotator performs frequency offset compensation in either the time domain or the frequency domain;

a phase compensator to perform a phase compensation on the frequency offset compensated symbol signal according to an estimated residual phase error of the pilot signal; and

wherein the phase compensator comprises:

a data buffer for storing the data signal of the frequency offset-compensated symbol signal;

a pilot subchannel compensator, coupled to the pilot subchannel estimator, for compensating the pilot signal of the frequency offset-compensated symbol signal and for generating a channel-compensated pilot signal;

a phase error estimator, coupled to the pilot subchannel compensating device, for generating an estimated residual phase error between the channel-compensated pilot signal and an original pilot signal transmitted by the transmitter; and

a first phase rotator, coupled to the phase error estimator and the data buffer, for compensating the data signal of the frequency offset-compensated symbol signal according to the estimated residual phase error.

- **Cancel** Claim 19.

- **Replace** Claim 20 **with**:

A method for carrier frequency offset compensation used at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises at least a pilot signal and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal, the method comprising:

generating an estimated frequency response of the pilot signal;

determining a phase error according to the estimated frequency response of the pilot signal of the symbol signal in a frequency domain and the estimated

frequency response of the pilot signal of a following symbol signal in the frequency domain;

generating an estimated carrier frequency offset according to the phase error;

calculating an accumulated phase rotation according to the estimated carrier frequency offset;

based on the magnitude of the carrier frequency offset, utilizing a phase rotator to perform carrier frequency offset compensation according to the accumulated phase rotation in either the time domain or the frequency domain;

wherein if the subchannels comprise a plurality of the pilot subchannels for transmitting a plurality of pilot signals, then the pilot subchannel estimator is for generating a plurality of estimated frequency responses corresponding to the pilot signals, and the frequency offset estimator coupled to the pilot subchannel estimator is for generating an estimated carrier frequency offset according to the estimated frequency responses of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of a following symbol signal; and

further wherein the estimated carrier frequency offset is generated through generating a plurality of phase errors, wherein each of the phase errors is generated according to the estimated frequency response of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of the following symbol signal, and then averaging the phase errors.

- **Cancel** Claims 23 & 24

- **Replace** Claim 25 **with**:

A method for phase compensation used at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises at least a pilot signal and at least a data signal, and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal and at least a data subchannel for transmitting the data signal, the method comprising:

extracting the pilot signal;

generating an estimated residual phase error between the extracted pilot signal and an original pilot signal transmitted by the transmitter;

compensating a following symbol signal according to the estimated residual phase error;

utilizing a channel compensator to compensate the following symbol signal after compensating the following symbol signal according to the estimated residual phase error;

wherein if the subchannels comprise a plurality of the pilot subchannels for transmitting a plurality of pilot signals, the estimated residual phase error is generated through extracting the pilot signals, generating a plurality of estimated residual phase errors between each of the extracted pilot signal and a corresponding original pilot signal, and averaging the estimated residual phase errors; and

further wherein estimating a carrier frequency offset generated through the residual phase errors, wherein each of the residual phase errors are generated

according to a estimated frequency response of one of the pilot signals of the symbol signal and the estimated frequency response of a corresponding pilot signal of the following symbol signal, and then averaging the phase errors.

- **Cancel** <u>Claim 26</u>.

- **Replace** <u>Claim 27</u> **with**:

A method for phase compensation used at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises at least a pilot signal and at least a data signal, and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal and at least a data subchannel for transmitting the data signal, the method comprising:

storing the symbol signal;

extracting and compensating the pilot signal to generate a channel-compensated pilot signal;

generating an estimated residual phase error between the channel-compensated pilot signal and an original pilot signal transmitted by the transmitter;

extracting and compensating the data signal according to the estimated residual phase error;

utilizing a data subchannel compensator to compensate the data signal after compensating the data signal according to the estimated residual phase error; and

wherein if the subchannels comprise a plurality of pilot subchannels for transmitting a plurality of pilot signals, the method comprises: generating a plurality of phase errors, wherein each of the phase errors is determined according to one of the pilot signals and a corresponding original pilot signals; and averaging the phase errors.

- **Cancel** <u>Claim 29</u>.

Allowable Subject Matter

4. Claims 1, 6, 9, 12, 16-18, 20, 25, 27-28 and re-numbered as claims 1-to-11 respectively are allowed.

5. Claims 1, 6, 9, 12, 16-18, 20, 25, 27-28 and re-numbered as claims 1-to-11 respectively are allowable over the prior art of record because the cited references do not contain the specified limitation of An apparatus for carrier frequency offset compensation at a receiver of a communication system, wherein a symbol signal modulated by a carrier is transmitted via a plurality of subchannels, wherein the symbol signal comprises a pilot signal and the subchannels comprise at least a pilot subchannel for transmitting the pilot signal, the apparatus comprising: a pilot subchannel estimator for generating an estimated frequency response of the pilot signal; a frequency offset estimator, coupled to the pilot subchannel estimator, for generating an estimated carrier frequency offset according to a phase error between the estimated frequency response of the symbol signal in a frequency domain and an estimated frequency response of a following symbol signal in the frequency domain; a phase

accumulator, coupled to the frequency offset estimator, for calculating an accumulated phase rotation according to the estimated carrier frequency offset; and a phase rotator, coupled to the phase accumulator, for carrier frequency offset compensation according to the accumulated phase rotation, wherein based on value of the estimated carrier frequency offset, the phase rotator performs frequency offset compensation in either the time domain or the frequency domain; wherein if the subchannels comprise a plurality of the pilot subchannels for transmitting a plurality of pilot signals, then the pilot subchannel estimator is for generating a plurality of estimated frequency responses corresponding to the pilot signals, and the frequency offset estimator coupled to the pilot subchannel estimator is for generating an estimated carrier frequency offset according to the estimated frequency responses of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of a following symbol signal; and further wherein the estimated carrier frequency offset is generated through generating a plurality of phase errors, wherein each of the phase errors is generated according to the estimated frequency response of one of the pilot signals of the symbol signal and that of a corresponding pilot signal of the following symbol signal, and then averaging the phase errors.

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to SUDHANSHU C. PATHAK whose telephone number is (571)272-5509. The examiner can normally be reached on 9am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Chieh M. Fan can be reached on 571-272-3042.

The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/Sudhanshu C Pathak/
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